

NSU- LSMSA Makers Club: Advanced STEM Educational Modules and Enhanced Experiential Learning

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Abstract

This paper describes advanced educational activities of the STEM makers club, which combines Northwestern State University (NSU) and The Louisiana School for Math, Science, and the Arts (LSMSA). The main objective of this Makers Club is to make students excited about STEM and to increase the number of students who are interested in STEM related careers. The newly founded club (NSU-LSMSA Makers Club) emphasizes innovation and hands-on experience for all participants. Furthermore, it promotes building a spirit of teamwork and sharpening problem-solving skills. Different teaching modules have been developed and applied. The paper presents various structured activities reports experiential learning from its participants.

1. Introduction

Since the 1960s there have been lots of efforts to develop curriculum projects for science and mathematics. Efforts to improve science, technology, engineering, and mathematics (STEM) education in grades K–12 are not new. Yet, despite the increased attention to STEM in policy and funding arenas, STEM education in some states is still lacking and requires a special attention.

Enquiry-based learning and deeper understanding has gained significant attention lately [1,2]. Due to its importance, lots of efforts focused on the K-12 STEM education. Recently many reforms have appeared to address the scientific reasoning, critical thinking, and problem solving approaches. One of the ways to address the enquiry-based learning is through regular structured and well-designed STEM activities [3-7]. In addition, these structured activities can be used as a means for the experiential learning which changes mindset and requires considerable time and effort. According to Rogers (1969),

Experiential Learning is the application of knowledge that focuses on the needs and wants of a person and is related to the change and growth of that person. However Kolb (1984) thinks that experiential learning is like a four-stage process. The four-stages of experiential learning is: Concrete Experience (*Doing*), Reflection (*Observing*), Abstract Conceptualization (*Thinking*), and Active Experiment (*Planning*). Some of the key principles of experiential learning is: Learning is more efficient when the subject is relevant to the students' interests, Students should have control over the learning process. The best way for students to benefit from experiential learning is by cooperating these major elements: Meaning Making, Paradigm Shifting, and Self-Understanding. The instructor's role in experiential learning is to have a positive atmosphere, to allow students to make and learn from their mistakes, and to provide the freedom that students need to experiment during the task. A lot of students can and has benefited from experiential learning.

In the last few years, STEM related activities have spread widely. STEM clubs, makers clubs, makers workshops, science show cases, and robotics competitions have been expanded across all the states. The host of these clubs/activities is normally school and public libraries, classrooms, and STEM related departments at university facilities. Almost all these activities target the K-12 educators. Students involved in these makers or STEM activities are normally engaged in projects which progress in complexity and students are trained to be independent.

In August 2016 the NSU-LSMSA Makers Club was founded. The Club combines the Department of Engineering Technology (ET) at NSU and the LSMSA. All practices were designed to enable students to gain the

knowledge and hands-on experiences needed to further their professional and academic growth so that they can develop skills that will allow them to contribute meaningfully as engineering technology professionals.

The current enrollment of the club is 20 students. Participating students are taught theory and gain research and hands-on experiences at NSU laboratories and workshops. Great ideas from participating students related to energy and defense for example have been generated and proposed. Students currently are working on the design and implementation of their projects. The NSU-LSMSA Makers Club members meet three hours every week to interact, learn, and report progress.

The sections below, describe the different projects taught at the NSU-LSMSA Makers club in addition to other managerial and assessment aspects of this STEM related activities

2. Materials taught at the NSU-LSMSA makers club:

The NSU-LSMSA Makers Club meets twice a week for three hours. This is equivalent to 3-credit hour course at the college level. The class is structured to deliver theory and basic science in addition to hands-on experience. Theoretical subjects taught or reviewed to the participants in the NSU-LSMSA Makers Club include, Basics of engineering design, Alternating current principals and magnetism, Applied digital electronics, Introduction to Arduino and Raspberry Pi Microcontrollers , Basics of soldering, and Circuit Design using Fritzing and Multisim simulations

Students at the makers club were exposed to and trained on many hands-on skills. The club has provided students with broad experience in metalworking through the use of tools, machines, and materials that are basic to complete their projects. Also, students were mentored and trained on both hand and machine-tools operations, and supplies. Hands-on experience and laboratory work include: Design using 123 Design and inventor, 3D printing, Noise maker soldering kit, PCB board etching, Circuit design, modeling, and simulation using Fritzing and Multisim, Hand- and machine-tools

3. Projects and ideas generated by participants:

The NSU-LSMSA Makers Club boasted a significant number of students actively involved in researching their

designed projects. The course is designed to have students propose a project or an experimental design within the first three weeks of classes, begin work on gathering data through the first part of the fall or spring semester, and compose the results in a comprehensive lab report. Each student presents his/her findings at the NSU annual research day held in late April [8]. The Engineering and Science faculty of both NSU and LSMSA attend the activity and serve as judges to this event as needed. Examples of projects designed and currently implemented by students include:

- Humanoid Robot: as a platform for machine learning, artificial intelligence, and computer vision research. This robot utilizes an advanced chip, *Nvidia Jetson TX2 System*, and will act as a platform for development in specific fields.
- Energy harvesting through a trampoline. In this project, students proposed to design a sports machine where they can exercise and harvest energy simultaneously. The objective of this project is to create something fun and beneficial to the society. The students wants in extended the concept of energy harvesting to large stadiums.
- T-Shirt Cannon: The NSU University needed a T-Shirt Cannon to be used during the sports activities. The students responded to this call and they completed their initial design. Currently it is the stage of fabrication.
- Electromagnetic Launcher: Improved design and physics. A group of students were amazed by the concept and physics of electromagnetic launcher. Hence, they decided to prove the concept in the laboratory environment. Due to its extraordinary power, their idea is to use such a concept to send missions to explore other planets. Students wish to communicate with funding agencies such as NASA to support this project.
- Smart Controller: In this design, students noticed a waste of energy in their dormitory and they decided to design a smart controller, which can be modified and programmed via portable device such as cell phone and tablet. The concern of students is to save energy and to support our Green Campus Initiative.
- Solar Tracker: In this project, the students design, fabricate and program a solar tracker. A prototype is already fabricated. This project involved 3D printing, light sensors, and Arduino programming.

4. Dissemination of research results and findings:

We always emphasize to our students that gaining research experience at the high school can improve their chances of getting into a top College/University. Many of our previous students who were serious and made good progress in their research were successful to secure full scholarship at high rank universities. Participants in the NSU-LSMSA Makers Club generated great ideas, which are related energy harvesting, robotics, and launching devices. The Makers Club is designed to provide students not only with knowledge but also equip them with the essential skills in writing for publication such as how to write abstracts, papers, do oral presentations, and prepare posters

5. Summary

The main objective of the NSU-LSMSA Makers Club is increase the number of students who are interested in STEM related careers. We are very excited about the establishment of the NSU-LSMSA Makers Club. The results and achievements of the club are very promising and we are encouraged by these results. Participants were taught the engineering in a fun way. Students were taught basics of research and how to develop into and independent thinkers and researchers. Participants were successful in presenting their work at professional meetings. Our future activities will include an implementation of assessment plan to track improvements and to measure student engagements. The Makers Club is also to inform students about educational opportunities at host university, NSU. Although the club still in the inaugural year, the initial feedback from students about the NSU-LSMSA Makers Club is that they are very pleased with its activities and they would recommend it to their colleagues. Partnership between NSU and LSMSA will persist into the future and will work diligently to develop the future scientists and engineers.

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Figure 1. Representative members of the NSU-LSMSA Makers Club with their mentors and instructors. From Left to right Mary Pace (LSMSA), Mathew Weick (LSMSA), Alastair Dunn (LSMSA), Curtis Desselles (NSU lab. Technician), Dr. Mauricio Escobar (LSMA Instructor), Will Heitman (LSMSA), Hoa Nguyen (LSMSA), McKenzie Cutrer (LSMSA), and Dr. Jafar F. Al-Sharab (NSU Engineering Technology Professor and the founder club)